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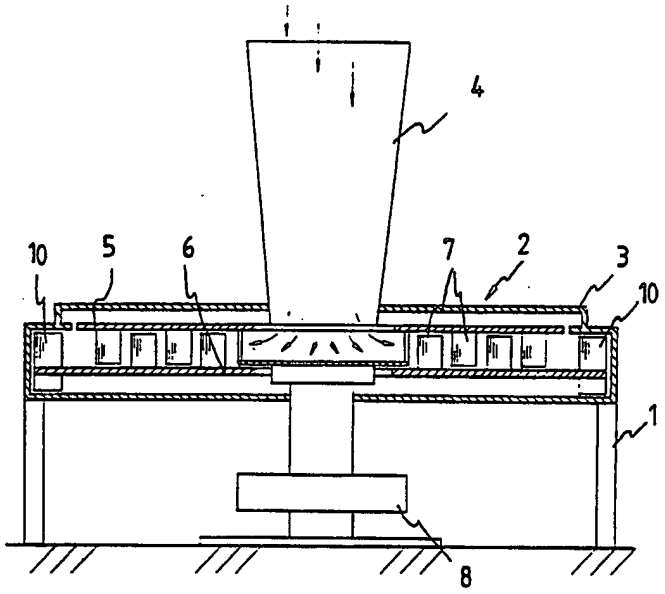

(57) Abstract

The present invention concerns an apparatus for handling putty- and paste-like materials in particular, said apparatus (2) comprising concentric rotors (5, 6) rotating in opposite directions and equipped with impact stops (7) from which stops the processed material is expelled by the effet of centrifugal forces outwardly against the inner wall of a drum (3) enclosing the rotors. According to the invention at least one of the milling rotors (6) of the apparatus is provided with discharge vanes (10) rotating with the rotor. The discharge vanes (10) are adapted to an at least essentially vertical position and having their outer edges placed close to the inner wall of the drum (3) and pointing toward the wall. At the level of the discharge vanes (10), to the wall of the drum (3), there is arranged a discharge hole, whose extension is formed by a discharge pipe (9). The material expelled against the inner wall of the drum by the effet of the rotation of the rotor (6) is scraped in front of the discharge vanes (10) and removed via the discharge pipe (9).

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Apparatus for the processing of mixes and pastes

The present invention relates to an apparatus in accordance with the preamble of claim 1 for the processing of mixes and pastes or equivalent products, in particular for the mixing and/or grinding of such products.

An apparatus for said purpose conventionally comprises a body unit onto which is adapted a drum, whose inside has at least two concentric rotors equipped with impact stops and rotatably mounted on bearings so that their axes are essentially parallel with the drum axis, whereby at least one of the rotors is adapted to revolve contradirectionally to the other rotor (or the other rotors). The apparatus further has drive means for the rotation of the rotors, said drive means being connected to power sources; and finally, feed and discharge means for the material to be processed.

Different apparatuses are used for the processing of materials depending on the characteristics of the material characteristics such as its hardness in its state of occurrence; its viscosity, particle size, and other factors. Dry, pulverized materials and distinctly liquid mixes are obviously easy to mix and/or grind. By contrast, stiff mixes such putties, pastes and the like are difficult to mix due to their high viscosity and cohesion which is a measure of the internal consistency. A typical mixer for such materials is the double-Z mixer in which two Z-shaped rotor arms revolve in opposite directions. One application of the principle is the apparatus known as the Nauta mixer in which a mixing screw revolves about the sides of a conical chamber. In screw mixers the mixing speed is low, and due to the high viscosity of the material, high mixing forces are involved. The efficiency obtained in this kind of mixing is out of proportion in comparison to the power imposed on the mix that is converted almost totally into heat.

Known in the art are also a great number of mills capable of

grinding both dry and liquid materials. In these mills, the material is typically discharged via a screening device, whereby the material must be in the form of a dry powder, or alternatively, a liquid with relatively low solids. In addition to the mills described above, toothpastes and other creams are also mixed in a mill having pinned rotors with impact stops revolving in opposite directions (so-called pin mill or pin mixer), said mill also being widely used for milling and mixing, e.g., corn and mash as well as different kinds of fodder. In the pin mill the material is scattered from impact stop to another until the material is discharged from the mill after a retention time of approx. 0.01 ... 0.1 s.

Prior art techniques suffer from several drawbacks. For instance, the mills and mixers of the above-described design are problematic in, e.g., the discharge of the processed material. The problem is greatest when the processed material is a paste, putty or similar mixture of solids and liquid having the solids in excess of half the mixed quantity, or alternatively, when the viscosity of the liquid is high. Although several pin mill patents describe different kinds of material discharge systems, they fail, however, to discuss the difficulties associated with the handling of putty-like materials. In most cases the patents describe the material discharge to take place at the center of a conical bottom. DD Patent Specification No. 136579 for instance discloses a design in which the material is gravity dropped from the vertical sides of the rotor to the bottom, wherefrom it is conveyed away.

In the apparatus of the Estonian Desintegrator Corporation, the paste-like materials are removed by means of a band conveyor running about the apparatus. A problem arises from the material expelled from said conveyor, whereby the material can land on the band guides; furthermore, the material falling on the band causes band wear.

It is an object of the present invention to avoid the drawbacks of the prior art technology and to provide such a novel apparatus for the handling of, in particular, putties and pastes that will make the discharge of processed material an easy operation. A further object of the invention is to achieve an apparatus capable of removing air from high-viscosity materials after grinding and/or mixing.

The invention is based on the use of an apparatus with a design of the type described in the introduction above. Thence, the apparatus has concentric rotors revolving in opposite directions that cause the processed material to be expelled by centrifugal forces outward against the inner walls of the drum enclosing the rotors (pin mill construction). The invention is based on the concept that at least one of the rotors, or milling gates, of the apparatus is provided with discharge vanes rotating along with the rotor. The discharge vanes are arranged to a position essentially different from horizontal, their outer edges being located close to the inner wall of the drum and aligned pointing toward the wall. At the level of the discharge vanes, to the wall of the drum, there is arranged a discharge hole followed by a tubular extension. With the rotation of the rotor, the material ejected against the inner wall of the drum is thus scraped in front of the discharge vanes and further expelled through the discharge pipe.

More specifically, the apparatus in accordance with the invention is characterized by what is stated in the characterizing part of claim 1.

According to a preferred embodiment of the invention, the discharge vanes are aligned essentially radially about the rotor rims. The number of the vanes is preferably from two upwards. However, in principle, the apparatus in accordance with the invention can also operate with one discharge vane provided that the rotor can be balanced. The vanes are advantageously adapted along the rim of the rotor backed by a

washer plate with an oversize diameter. The above-mentioned discharge pip is preferr dly aligned tangentially with th outer side of the drum. The number of discharge holes and pipes can be increased as necessary.

According to another embodiment, the discharge vanes are concavely curved in the rotational direction of the rotor. In an alternative embodiment they are essentially planar. The most preferred alignment of the vanes is essentially vertical in all embodiments.

In an apparatus according to the invention, there is arranged a clearance between the outer rim of each discharge vane and the inner wall of the drum, whereby the clearance is advantageously larger than the particle size of the largest aggregate in order to avoid seizure and unnecessary wear.

With the use of the apparatus in accordance with the invention, all material expelled against the inner wall of the drum is scraped in front of the discharge vanes and finally discharged via the hole adapted to the wall having, moreover, a substantial radial velocity according the power of the rotor.

The design is benefited by a relatively low wear of the wall owing to the constant layer of material protecting the wall. The apparatus design manages without any additional moving parts dedicated to the discharge of the material, and the only wearing part is the outer edge of the discharge vanes in case the vanes are aligned radially outward.

The momentum imparted to the mix in the apparatus in accordance with the invention can be increased to an extremely high level. This is because a high power is imposed on a small quantity of material at a time. Thence, a disintegration of cell structures and material surface becomes possible and an intimate contact between the different materials in the paste is established; further,

pigment agglomerations can be disintegrated, etc.

It must be noted that the operation of the apparatus in accordance with the invention requires that the rotors revolve sufficiently fast to avoid the fill-up of the apparatus and that the centrifugal force achieved exceeds substantially the viscose and adhesion forces imparted by the material to be mixed against the walls of the apparatus. Depending on their size, the two- or multirotor mixers of the described type typically have a peripheral speed of 15 to 100 m/s, whereby the speed of rotation is sufficient to ensure the operation of the apparatus provided that the processed volume of material is maintained continuously at a low level. Then, the apparatus operates in a discontinuous manner in relation to the flow of the material to be mixed and/or ground: in other words, the apparatus volume is only partially filled with material.

As mentioned above, the discontinuous manner of mixing always involves the potential problem of air or ambient gas getting entrained with the mix. In the apparatus in accordance with the invention this phenomenon can be avoided, when necessary, by bringing the material to be processed to collide at a high velocity against a solid wall, whereby the entrained air is re-expelled from the mix. Thus, the apparatus achieves a similar end result as, e.g., the vibration of concrete.

According to a preferred embodiment of the invention, air that is still entrained in the mix or paste upon discharge from the pin mill is removed by conducting the material through a screw conveyor equipped with a helix screw (i.e. a coil-shaped mixing screw). Said helix screw construction provides low-efficiency mixing action, which surprisingly has proved to be advantageous as far as air entrainment is concerned. Thus, in the present embodiment, during the constant mixing action of the helix screw of the screw conveyor, it is possible to withdraw air through the open central part of the screw. The efficiency of the air

entrainment may be even further improved by increasing the temperature of the mix or paste or by applying reduced pressure to the screw conveyor. Any suitable conventional vacuum pump may be employed for the latter purpose, the preferred pressure of the screw conveyor (and the mill unit) being about 0.01 to 0.5 bar, in particular about 0.05 to 0.15 bar, e.g. about 0.1 bar.

The invention is next examined with the aid of the attached drawings.

Figure 1 shows the apparatus in a partially sectioned side view, while Figure 2 shows a corresponding top view.

Figure 3 shows a partially sectioned top view of a preferred embodiment of the invention provided with a screw conveyor for the discharged material.

A pin mill in accordance with the invention comprises a body frame construction 1 made of steel and having preferably the shape of a rectangle with support legs mounted to its corners on which the frame rests permanently mounted onto a base. The other end of the body frame 1 has a permanently mounted (not shown) motor bed which supports two electric motors attached to the motor bed with their shafts aligned vertically. Mounted to the body frame 1 is a mill unit 2 comprising a drum 3 with a relatively low but wide shape. Coinciding with a feed hole provided to the upper surface of the drum 3, there is arranged a feed hopper 4 for the material to be processed that can be either attached to the upper side of the drum 3, or alternatively, separately permanently mounted.

Inside the drum 3, there are two milling rotors 5 and 6 rotationally mounted on bearings, and the planar base plates of the rotors are provided with studs 7 aligned orthogonally to the rotational direction of the base plates. The milling rotors 5 and 6 are concentrically mounted on bearings on the same shaft. For the rotation of the milling rotors 5 and 6,

they are connected via V-belts (not shown) as well as a drive shaft and a pulley 8 to the drive shafts of said motors so that the rotors 5 and 6 are rotatable in opposite directions.

To the side of the drum 3 there is arranged an essentially horizontal discharge pipe 9, which is mounted to fit the hole formed to the wall of the drum 3. As evident from Fig. 2, the discharge pipe is aligned tangentially from the outer wall of the drum 3.

The diameter of the base plate of the lower milling rotor 6 is at least slightly larger than the diameter of the base plate of upper rotor 5. Onto the extended base plate rim of the lower rotor 6 are adapted discharge vanes 10 rotating with the lower base plate, whereby the vanes are aligned essentially vertical. In the case of the exemplifying embodiment, the discharge vanes 10 are of metal, but equally well they can be made of a ceramic material or even from hard-vulcanized rubber. The discharge vanes 10 are extended slightly below the lower base plate of the rotor 6. This design ensures that also such material on the inner wall of the drum that has already dripped under gravity for some length can be scraped.

The diameters of the drum 3 and the milling rotor 6 are designed so that a clearance at least sufficient for the largest particles of the material to pass remains between the vertical inner wall of the drum 3 and the outer rim of the rotor having the largest diameter.

In the embodiment illustrated in figures 1 and 2, the vane 10 is essentially planar. The main axis of the vane plane is coincident with the radius of the drum 3.

In an alternative embodiment, the vane 10 can be shaped concavely curved against the rotational direction of the rotor, wher by it can be designed to have an approximate shape and function of, e.g., the snowplow of a plowing

vehicle.

The pin mill in accordance with the invention has the following function: The milling rotors 5 and 6 are rotated by means of electric motors in opposite directions. The material to be milled and mixed is fed via the hopper 4 so that material first hits the rotating plate of the lower rotor and is expelled therefrom by the effect of centrifugal forces outwardly until it meets the first impact stop 7. From this stop the material is expelled to the next impact stop and further to the next and next until the material milled by the effect of the impacts hits the inner wall of the drum 3. All material expelled against the inner wall is scraped in front of the discharge vanes 10. During the scraping the material becomes homogenized and some of the air entrained therein is released. The material is then discharged via a hole in the wall of the drum and further, via the discharge pipe 9. The material scraped by the discharge vanes 10 achieves an elevated radial velocity determined by the rotational speed of the milling rotor 6.

Figure 3 shows the partial sectional top view of an apparatus according to the invention having a slightly different construction. Thus, the mill unit comprises a drum 11, inside of which there are three milling rotors 12, 13, 14 provided with impact stops 15. Two discharge vanes 16, 17 are fitted on the base plate of the lowest rotor 14. The rotation directions of the rotors are indicated by arrows.

In the embodiment depicted in figure 3 there is, however, provided a screw conveyor 18 adjacent to the pin mill unit. The screw conveyor 18 comprises a helix screw 19 mounted on ball bearings 20 within an open housing 21 and connected via a transmission machinery 22 to an electric motor 23 for rotation about its longitudinal axis. In the wall of the housing 21, close to the base of the helix screw 19, there is an opening (not shown) which is connectable to a vacuum pump. The opposite end of the housing 21 is tapered and

connected to a pipe 24. Said pipe may, in its turn, be connected to any suitable apparatus for further processing of the material, e.g. to a concrete mixer.

As shown in the figure, the housing 21 of the screw conveyor 18 is mounted to a discharge opening 25 in the wall of the drum. In this embodiment, the opening covers over 90' of the periphery of the drum 11 and is thus wider that was the opening 9 in figure 2.

The operation of the apparatus according to this embodiment is also depicted in figure 3. The pin mill unit works in a similar way as the one described above. Thus, on meeting the impact stops 15 of the milling rotors 12, 13 and 14, the material fed to the mill unit gets milled and mixed. It then gathers on the inside of the drum wall, as indicated by the dark stripes of different width on the inside of the drum wall. When the material is scraped from the wall by one of the discharge vanes 16, it is kneaded in front of the moving vane and gradually becomes homogenized. At least some of the air entrained in the material is also released during this kneading action. The material is then discharged through the opening 25 in the wall and, due to the radial velocity given by the discharge vane 16, it continues in a tangential movement until hitting the helix screw 19 and the far wall of the housing 21. The screw 19 conveys the mixed and milled material for further processing, if needed, via the pipe 24.

Since the conveying action of the helix screw 19 is rather inefficient, it takes several turns of the screw to move the material even a lenght corresponding to one flight of the screw. On the other hand, this slow conveying action is accompanied by a kneading action which enhances entrainment of air contained in the material. The air released from the material in the screw conveyor is conducted out of the housing 21 through the central part of the helix 19 via the opening mentioned above. To enhance the air entrainment both in the mill unit and in the screw conveyor, the opening

is connected to a vacuum pump, which reduces the pressure inside the apparatus to 0.01...0.5 bar, for instance to about 0.1 bar, and pumps out the air released.

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WHAT IS CLAIMED IS:

1. An apparatus for handling putty- and paste-like materials in particular, said apparatus comprising,

- a frame (1),
- a drum (3; 11) adapted to the frame,
- adapted to the inside of the drum (3; 11), at least two concentric rotors (5, 6; 12, 13, 14) equipped with impact stops (7; 15) and rotatably mounted on bearings so that their axes are essentially parallel with the drum axis, whereby at least one (5; 13) of the rotors is adapted to revolve contradirectionally to the other rotor(s) (6; 12, 14),
- drive means (8) of the driven rotors (5, 6; 12, 13, 14), attached to power sources, and
- feed means (4) of the material to be processed, attached to the drum; and discharge means (9, 10; 16, 18) of the processed material,

c h a r a c t e r i z e d in that

- the discharge means of processed material comprise discharge vanes (10; 16) adapted to the outer rim of at least one rotor (6; 14), said vanes being aligned to a position essentially different from horizontal and having their outer edges placed close to the inner wall of the drum (3; 11) and the vanes being aligned toward the inner wall; and a discharge conduit (9; 18) which is adapted to fit to an opening formed to the wall of the drum (3; 11) essentially at the level of the discharge vanes (10; 16) and is attached to the wall, whereby the material accumulated to the inner wall of the drum by the effect of the rotation of the rotor (6; 14) is scraped in front of the discharge vanes (10; 16) and removed via the discharge conduit (9; 18).

2. An apparatus in accordance with claim 1, c h a r a c - t e r i z e d in that the discharge vanes (10; 16) are essentially radially aligned in respect to the rotors (5, 6;

12, 13, 14).

3. An apparatus in accordance with claim 1 or 2, c h a r a c t e r i z e d in that the discharge vanes (10; 16) are concave against the rotational direction of the rotor (6; 14).

4. An apparatus in accordance with claim 1 or 2, c h a r a c t e r i z e d in that the discharge vanes (10; 16) are essentially planar.

5. An apparatus in accordance with any of the foregoing claims, c h a r a c t e r i z e d in that the discharge vanes (10; 16) are essentially vertical.

6. An apparatus in accordance with any of the foregoing claims, c h a r a c t e r i z e d in that the discharge vanes (10; 16) are mounted to the outer rim of a milling rotor (6; 14) having an extended diameter.

7. An apparatus in accordance with any of the foregoing claims, c h a r a c t e r i z e d in that the discharge vanes (10; 16) are mounted to the base plate of the lower rotor (6; 14) so as to extend partially below the lower surface of the base plate.

8. An apparatus in accordance with any of claims 1...7, c h a r a c t e r i z e d in that the clearance between the outer edge of the discharge vanes (10; 16) and the inner wall of the drum (3; 11) is preferredly larger than the maximum particle size of the processed material.

9. An apparatus in accordance with any of the foregoing claims, c h a r a c t e r i z e d in that the discharge pipe (9) is aligned tangential to the outer wall of the drum (3).

10. An apparatus in accordance with any of the foregoing

claims, c h a r a c t e r i z e d in that the discharge conduit comprises a screw conveyor (18) adapted to fit the opening (25) in the wall of the mill unit.

11. An apparatus in accordance with claim 10, c h a r a c t e r i z e d in that the screw conveyor (18) includes a helix screw (19).

12. An apparatus in accordance with claim 10 or 11, c h a r a c t e r i z e d in that the screw conveyor (18) is connectable to a vacuum pump for reducing the pressure inside said conveyor and inside the mill unit.

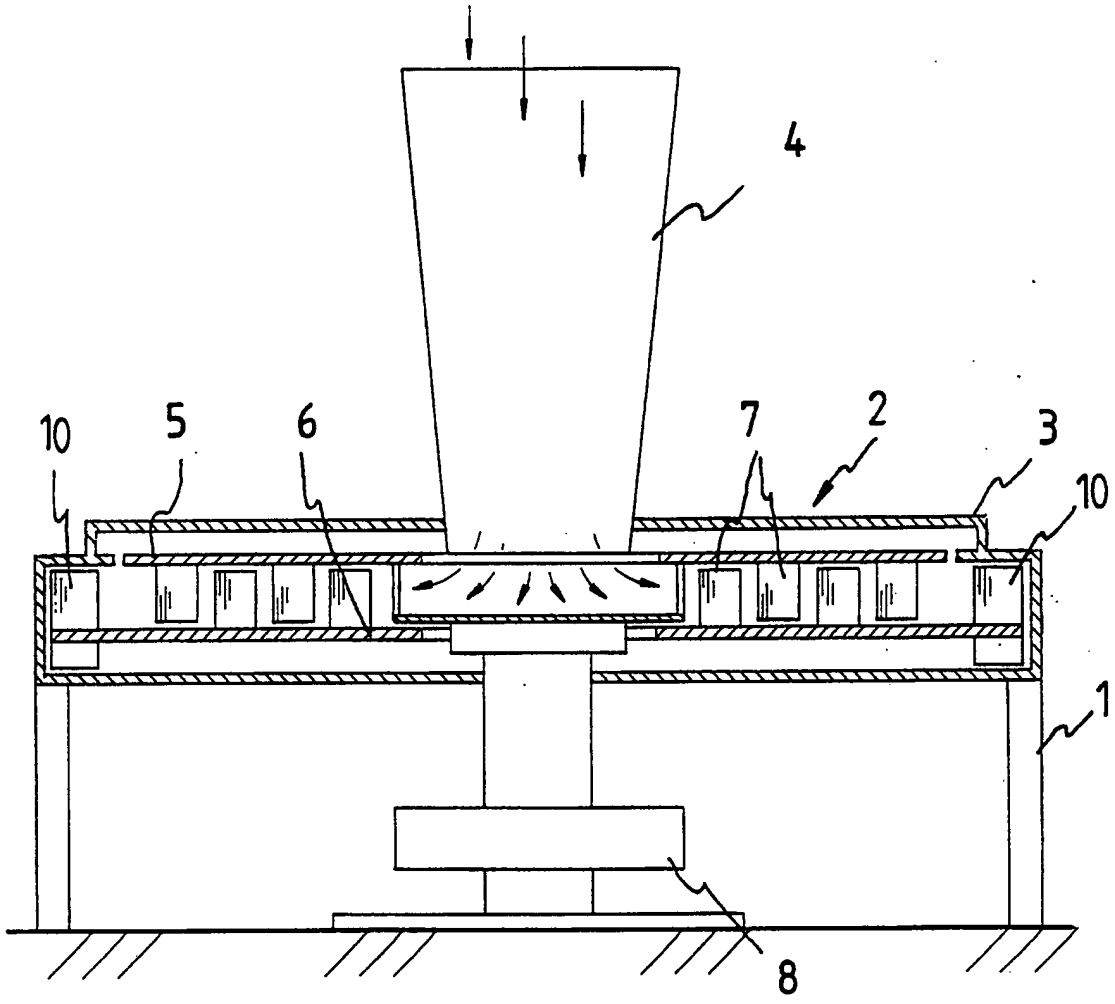

FIG. 1

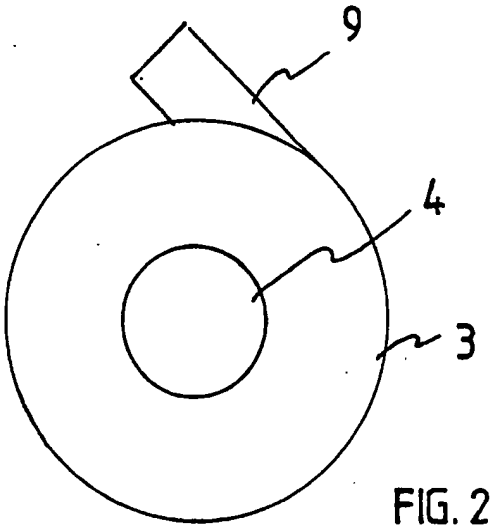

FIG. 2

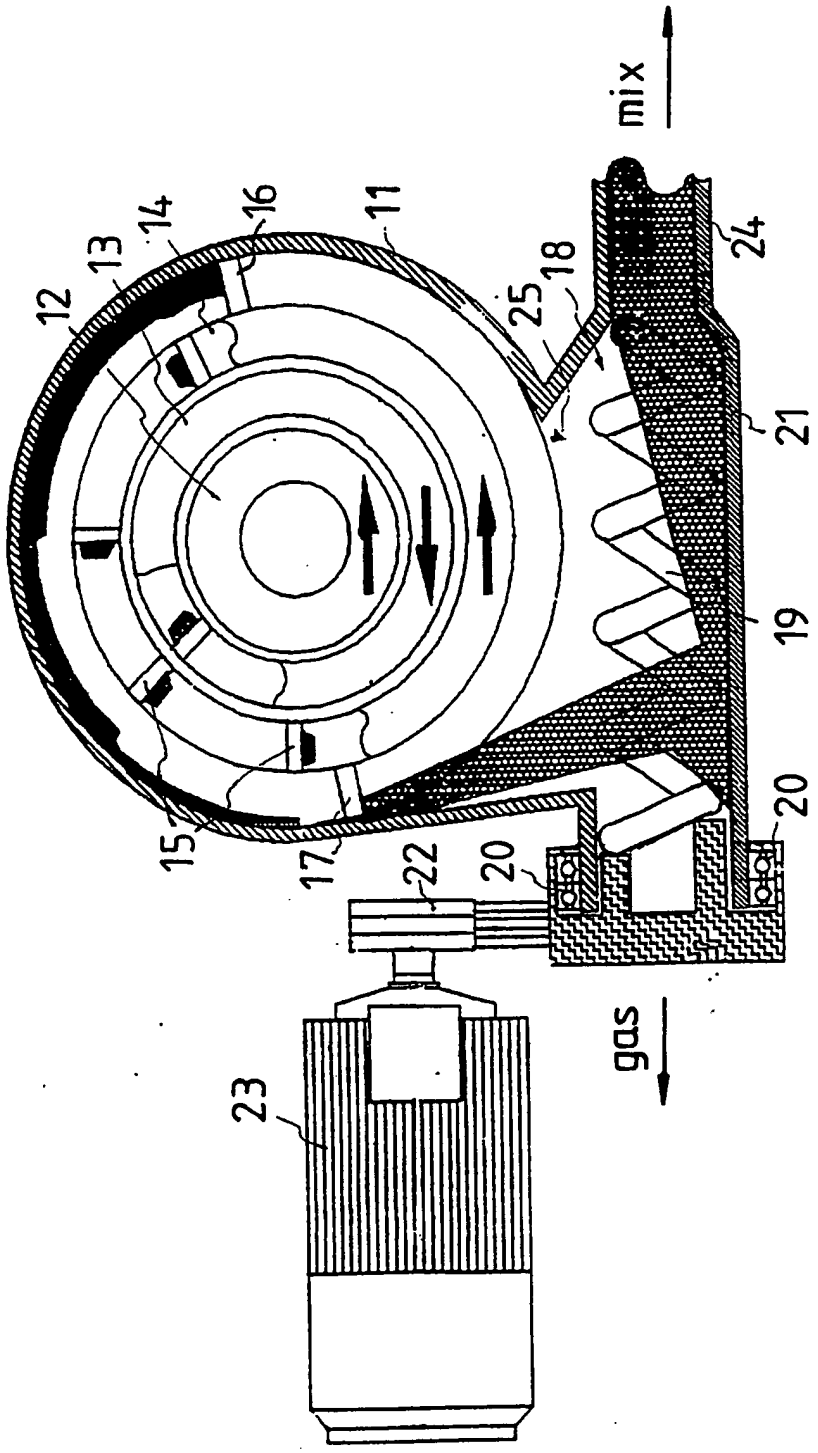

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 90/00280

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: B 01 F 7/00, B 02 C 13/22

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	B 01 F; B 02 C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	Derwent's abstract, No. 87-340 541/48, SU 1 304 870, publ. week 8748 (IVAN AGRIC INST) --	1,2,4-7
Y	Derwent's abstract, No. 89-284 086/39, SU 1 445 780, publ. week 8939 (MINSK GYPSUM CONS) --	1,2,4-7

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
6th March 1991	1991 -03- 08
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Wiva Asplund Wiva Asplund

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date